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# A Framework for Capturing the Hidden Stakeholder System

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## ABSTRACT

As programs rise in intricacy and scope, the number of stakeholders involved also increases, often driving an exponential growth in program complexity. This complexity is caused by the $n*(n-1)/2$ stakeholder relationships which form an underlying system that influences all aspects of the program. Understanding, managing, and leveraging this stakeholder system will greatly increase a program's probability of success. This paper provides a framework for capturing this stakeholder system in a series of architectural views. These architectural products document the program's stakeholder concerns and also illustrate how those stakeholders interrelate over the system's lifecycle. The ultimate objective for the framework and use of the resulting products is to allow for right-sized stakeholder involvement, promote effective use of resources, and increase the probability of overall program success with the assurance of lasting stakeholder commitment. Additionally, this unique insertion of Stakeholder Analysis and Social Network Analysis into an Architecture Framework fulfills an original intent of Architecture Framework, capturing the entire sociotechnical enterprise system. © 2012 Wiley Periodicals, Inc. Syst Eng 16: 251–266, 2013

Key words: architecture framework; social network analysis; stakeholder analysis; Department of Defense Architecture Framework (DoDAF); enterprise architecture

## 1. INTRODUCTION

As programs continue to rise in complexity and scope, the number of stakeholders involved also tends to increase. As the number of stakeholders increases, the number of relationships between those stakeholders increases exponentially. If these relationships are ignored or simply not understood, the program team may be entering an uncharted stakeholder minefield. When making a decision for a program, it is crucial to understand not only the first-order impacts of that decision but also the second- and third-order impacts. What if the decision negatively affects the customer of your customer? What if the decision requires a stakeholder to advocate for you, the same stakeholder that is upset because he or she has been excluded from previous decisions concerning your project? The proposed series of architectural views introduced in this paper is intended to provide systems engineers and program managers a much needed map of their specific stakeholder environment.

This paper opens with the background and motivation related to capturing the stakeholder system. It then describes a literature review and the initial framework the review inspired. This is followed by a summary of a pilot study which tested the framework on a US Department of Defense (DoD) program that utilized the DoD Architecture Framework (Do-

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DAF). Next, an updated, detailed framework is described. Following the framework description, a fictitious example is provided to illustrate how the new architectural artifacts may be employed. Finally, areas for future work are identified.

## 2. BACKGROUND AND MOTIVATION

In developing his book, *Why Decisions Fail*, Paul Nutt studied more than 400 strategic decisions and concluded that more than half of the decisions failed [Nutt, 2002]. Nutt's research revealed that failure is highly prevalent and that success or failure is more dependent on the actions of a decision maker than the particulars of a situation faced by that decision maker. One of the failure traps that Nutt highlights in his book is unmanaged political and social forces. Nutt states that, if stakeholder "interests can be uncovered and understood, the social and political forces that the interests stir up are usually manageable" [Nutt, 2002: 87].

In order to ensure stakeholder interests are incorporated into a program's design, many organizations employ formal architecture frameworks. Yet, even with these frameworks, most organizations still experience failures. The authors of this paper posit that a current deficit of architecture frameworks is that they focus on stakeholders solely via isolated viewpoints, thereby failing to capture the stakeholders as a system.

When taking a systems approach with regard to stakeholders, the focus shifts from individual stakeholders to their relationships. Exemplifying the foregoing is a simple but poignant example described by Edward Cornish [2004]: Imagine two people standing in front of you. There are several visible characteristics that can be observed (clothes, hairstyle, etc.); however, unseen is the relationship. What if they are a married couple? Bitter rivals? It is their interrelation that truly defines them.

Program stakeholders are naturally involved in complex relationships. These relationships can be complicated by a myriad of factors such as interagency rivalries, intra-agency conflicts, lobbyist agendas, and even the media [Forman, 2002]. Using the communications path formula from *A Guide to the Project Management Body of Knowledge*, there are in fact $n*(n-1)/2$ relationships, where $n$ is equal to the number of stakeholders [Project Management Institute, 2004]. In systems terminology, these relationships are interfaces, and defining these interfaces is crucial to defining the system.

Since program teams cannot successfully operate independent of their stakeholders, a framework is needed that captures and characterizes the stakeholder system [Smudde and Courtright, 2011]. In order to accomplish this, the authors took the following approach. First, a literature review was undertaken to study the fields of Architecture Frameworks, Stakeholder Analysis, and Social Network Analysis. Next, a draft set of architectural views was developed to capture the stakeholder interrelations and show how those interrelations evolve throughout the system development life-cycle. The feasibility of this framework was tested via a pilot study. Finally, the framework was updated based upon lessons learned via the pilot study.

## 3. LITERATURE REVIEW

The literature review examined the purpose and origin of three fields: Architecture Frameworks, Stakeholder Analysis, and Social Network Analysis. This review is summarized in the following subsections.

### 3.1. Architecture Frameworks

Architecture framework is a methodology used to describe a system using differing views and viewpoints. In this context, a view is "a representation of a whole system from the perspective of a related set of concerns," and a viewpoint is "a specification of the conventions for constructing and using a view" [ISO, 2007: 3–4; IEEE, 2000: 3–4].

The architecture framework concept was first documented by Zachman in 1987. In his paper titled "A framework for information systems architecture," he proposed leveraging the techniques from the field of Architecture to describe Information Technology (IT) projects [Zachman, 1987]. His framework described the same system from many different angles (or views) with different collections (or viewpoints) dedicated to different stakeholders. While the Zachman Framework is still popular and in use, several other architecture framework varieties are also in use [Mikaelian et al., 2011]. Some of the common varieties include: The Open Group Architecture Framework, Federal Enterprise Architecture, Ministry of Defence Architecture Framework, and NATO Architecture Framework.

The state of the practice for architecture frameworks within the DoD is appropriately named the DoD Architecture Framework (DoDAF). The current version, v2.0, focuses on capturing program data without deference to any particular view; however, to facilitate discussion and evaluation, 50 predefined models are proposed [US Department of Defense, 2009a, 2009b]. They consist of varying views from the following viewpoints: All Viewpoint, Capability Viewpoint, Data and Information Viewpoint, Operational Viewpoint, Project Viewpoint, Services Viewpoint, Standards Viewpoint, and Systems Viewpoint. Additionally, DoDAF 2.0 supports flexible "Fit-for-Purpose" views which are designed to describe an architecture in a manner that directly supports the decision making process while responding to internal and external stakeholder concerns [US Department of Defense, 2009a, 2009b].

From a standards point of view, architecture frameworks are guided by the joint standard ISO 42010/IEEE 1471, "Systems and software engineering—Recommended practice for architectural description of software-intensive systems" [ISO, 2007; IEEE, 2000]. This standard provides recommended guidance for use in developing and using architecture frameworks. The standard provides a conceptual framework that "establishes terms and concepts pertaining to the content and use of architectural descriptions." (page 4) This is followed by a description of architectural practices to include example usage. The standard does not promote any single framework but rather describes the aspects of architectural frameworks that are generally considered to be best practices. Among the best practices is identifying stakeholders, their roles, and interests or concerns with regard to the system under development [ISO, 2007; IEEE, 2000].

Despite scouring current literature and examining a variety of existing frameworks, no architecture framework was discovered that attempted to capture all stakeholders in a networked view. Typically, stakeholders are only captured via isolated viewpoints; however, some frameworks do capture the human interactions that support system functions. Yet these frameworks still fall short in capturing the interrelations of all stakeholders [Mikaelian et al., 2011; Mykityshyn and Rouse, 2006].

### 3.2. Stakeholder Analysis

Stakeholder Analysis studies the positive and negative effects of people who can influence, or are influenced by, a program. Although the field is rooted in management science, it has a wide and constantly growing range of applications. As our world becomes increasingly global and interconnected, the number and influence of stakeholders is increasing, creating an even stronger need for this field [Bryson, 2004]. The field of Stakeholder Management traces back to *Strategic Management: A Stakeholder Approach* [Freeman, 1984]. In fact, almost all literature on the subject continues to leverage Freeman's definition of a stakeholder.

Stakeholder Analysis is severely lacking in the public sector, so much so, that Bryson proposes this deficiency be studied as "an important research issue in its own right" [Bryson, 2003: 8]. Bryson observed that among the reasons for avoiding stakeholder analysis was the shortage of how-to guides, an assumption that the efforts will be significantly time-consuming, and/or a fear that the results will upset others, including the stakeholders being examined [Bryson, 2003]. Separating the fears from the facts, however, thoroughly understanding a program's stakeholders and actively managing the social and political forces has been shown to be the most successful approach to implementing strategic decisions [Nutt, 1999].

Relating stakeholder analysis to requirements analysis is the concept titled Quality Function Deployment (QFD). QFD originated in Japan in the late 1960s but has since spread throughout the world and is now practiced in a wide variety of fields such as automobiles, electronics, software, government service, banking, and health care [Chan and Wu, 2002]. The House of Quality (HOQ) is often employed while practicing QFD. The HOQ serves as a conceptual map that documents the voice of the customer (VOC). Technical factors are added to these customer-derived attributes. Next, the relationships between the technical factors are documented as positive (i.e., achieving one requirement facilitates the achievement of another) or negative (i.e., one requirement counters the achievement of another) [Hauser and Clausing, 1988]. Due in part to its popularity, QFD continues to evolve. For example, Sharif Ullah and Tamaki [2011] discuss how to address the uncertainties resulting from gaps in the VOC. Additionally, Hari, Kasser, and Weiss [2007] provide a 6-step multimethod to address a variety of lessons learned while using QFD in complex systems development.

While these tools and others assist in systems engineering, there is still a gap between quantitative, numbers-based approaches and feasible implementations [Clausing and Katsikopoulos, 2008]. Feasible implementations are often the result of Value Focused Thinking (as promoted by Keeney) and decisions based on their impact to the quality, cost, and/or time to delivery of a product [Keeney, 1992; Clausing and Katsikopoulos, 2008]. By definition, stakeholders may positively or negatively affect any of these three factors. For this reason, as stated by Clausing and Katsikopoulos [2008: 310], "The sociology and psychology of the people making the decisions is obviously important."

### 3.3. Social Network Analysis

Social Network Analysis examines the networks that intertwine individuals, groups, and organizations [Liebowitz, 2005]. This discipline has its roots in sociology and was commenced by George Simmel in 1908, when he wrote about the emergent behavior of a collection of humans [Scott and Carrington, 2011]. Like Stakeholder Analysis, Social Network Analysis can be and is applied in a variety of disciplines including anthropology, psychology, and management [Liebowitz, 2005].

Social Network Analysis is considered a significant part of the Systems Engineering field of Knowledge Management [Rao, 2005]. In Knowledge Management, social network analysis is leveraged to help understand how knowledge is created and transferred [Anklam, 2005]. In a similar regard, social network analysis can also be used to identify experts (or lack of experts) within an organization. These experts may take the form of the person most knowledgeable, the person best connected within a community, or a person that brokers or connects different communities [Ehrlich, Lin, and Griffiths-Fisher, 2007].

Also within Systems Engineering, the tools derived from social network analysis have been used to evaluate product development systems [Collins, Yassine, and Borgatti, 2009]. As described by Collins, Yassine, and Borgatti, standard systems engineering tools provide only a partial view of the development process whereas network analysis tools reveal the emergent properties. This is because network analysis focuses on the relations and patterns of relations. As further described by Collins et al., these techniques "provide insight into how individual elements affect institutions they are part of, and how institutions constrain their individual elements" [Collins, Yassine, and Borgatti, 2009: 57].

Social Network Analysis continues to be a growing field with an ever-increasing wealth of resources. In addition to commonplace social networking tools (e.g., Facebook, LinkedIn, etc.), software has been designed to specifically facilitate social network analysis by deriving relationships and automatically creating the social network map. Such approaches have been successful within corporations as well as within the field of Public Resource Management [Ehrlich, Lin, and Griffiths-Fisher, 2007; Prell, Hubacek, and Reed, 2009]. The downside to this software is that it either requires all users to utilize the same e-mail system or requires stakeholder interviews.

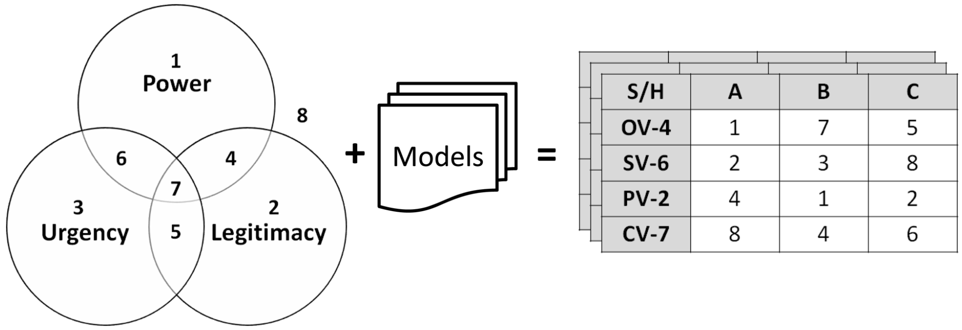


**Figure 1.** Graphical concept of the Stakeholder Crosswalk.

## 4. FRAMEWORK OVERVIEW

The knowledge gained from studying relevant literature was used to create the framework described below. This framework borrowed from the state of the practice of architecture frameworks and social network analysis, while keeping in mind the general concerns associated with performing stakeholder analysis. The products produced through the application of this framework are intended to assist an organization in performing stakeholder analysis and are also expected to be useful in support of tradeoff decisions that result from the organization's existing requirements analysis techniques.

The proposed framework consists of two parts: the Stakeholder Crosswalk and the Stakeholder Network Map. The Stakeholder Crosswalk is designed to show which stakeholders are relevant for a particular decision and at what stage(s) in the program they are relevant for that decision. The Stakeholder Network Map is designed to show the lines of influence between stakeholders. Figures 1 and 2 provide a graphical overview of the concept.

### 4.1. Stakeholder Crosswalk

The Stakeholder Crosswalk described below was tailored for application within the DoD, since that was the target of the pilot study (see Sec. 5). It is important to note, however, that the underlying concept of the Stakeholder Crosswalk can be easily applied outside of the DoD as long as the target program employs an architecture framework.

The Stakeholder Crosswalk is essentially a series of matrices. A separate matrix is dedicated to each program phase as defined in DoDI 5000.02 and summarized in Table I [US Department of Defense, 2008]. Across the top of each matrix is a listing of all identified program stakeholders, each with its own corresponding column. The rows of each matrix are dedicated to the predefined DoDAF models such as the SV-1 (which depicts system nodes, systems resident at the nodes, and interfaces between systems and nodes) and the OV-5 (which depicts inputs, outputs, and relationships of performing activities or organizations). The cells in the matrix contain information that categorizes each stakeholder's interest in the

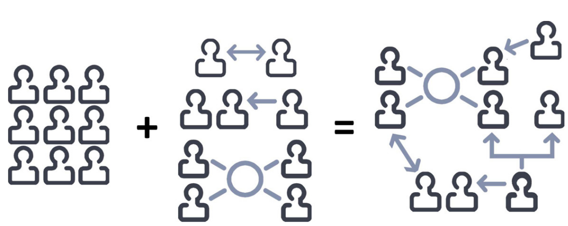

**Figure 2.** Graphical concept of the Stakeholder Network Map. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

**Table I. Program Phases from US Department of Defense [2008]**

| Phase | Purpose |
|---|---|
| Materiel Solution Analysis | *Assess potential materiel solutions* |
| Technology Development Phase | *Reduce technology risk, determine and mature the appropriate set of technologies to be integrated into a full system, and to demonstrate CTEs [Critical Technology Elements] on prototypes* |
| Engineering and Manufacturing Development Phase | *Develop a system or an increment of capability; complete full system integration…; develop an affordable and executable manufacturing process; ensure operational supportability with particular attention to minimizing the logistics footprint; implement human systems integration (HSI); design for producibility; ensure affordability; protect CPI by implementing appropriate techniques such as anti-tamper; and demonstrate system integration, interoperability, safety, and utility* |
| Production and Deployment Phase | *Achieve an operational capability that satisfies mission needs* |
| Operations and Support Phase | *Execute a support program that meets materiel readiness and operational support performance requirements, and sustains the system in the most cost-effective manner over its total life cycle* |

**Table II. Definitions from Mitchell, Agle, and Wood [1997]**

| Characteristic | Definition |
|---|---|
| Power | *A relationship among social actors in which one social actor, A, can get another social actor, B, to do something that B would not have otherwise done* |
| Legitimacy | *A generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, definitions* |
| Urgency | *The degree to which stakeholder claims call for immediate attention* |

items captured by the DoDAF model. This categorization is based on the work of Mitchell, Agle, and Wood [1997] and describes stakeholders through their possession of one or more of the following traits: power, legitimacy, and urgency. Table II provides working definitions for each of these traits. Finally, a roll-up matrix is provided. This matrix continues to have columns for the stakeholders and rows for the DoDAF models, but each DoDAF model is now given several rows, one for each phase of the program. This allows decision makers to quickly grasp not only which stakeholders are active in the current phase of the program, but also how each stakeholder's influence will rise or fall as the program progresses.

### 4.2. Stakeholder Network Map

The Stakeholder Network Map is a visual diagram of stakeholder interrelations. Maps of this type are often generated via specialized software. Software that relies on e-mail usage to automatically derive relationships and draw the corresponding network map works well in an organization that utilizes a single e-mail system; however, this software falls short in cases where multiple e-mail networks are in play. For example, network mapping software would be unable to traverse the multiple e-mail networks commonly in use within the DoD environment where separate military service e-mail networks as well as multiple defense contractor e-mail networks may all be used in support of one program. Interviewing stakeholders may work for some fields, but interviewing stakeholders presents two major problems. First, program

**Table III. Definitions from Anklam [2005]**

| Role | Definition |
|---|---|
| Central Connector | *Someone who is highly connected to many others in the network, who may be either a key facilitator or a "gatekeeper"* |
| Broker | *Someone who communicates across subgroups* |
| Boundary Spanner | *A person who connects a department with other departments* |
| Peripheral Specialist | *Someone less connected or not connected at all* |
| Pulse Taker | *Someone who uses his or her connections to monitor the health of an organization* |

**Table IV. Fictitious Examples of Stakeholders That Personify the Roles Identified by Anklam [2005]**

| Role | Fictitious Example |
|---|---|
| Central Connector | Personable and well-liked "gray beard" with many years of experience in the industry and extensive relationships with people at all levels throughout the community |
| Broker | Someone who recently transferred jobs and has personal connections to others within both his/her former subgroup and new subgroup |
| Boundary Spanner | Upper-level manager who is responsible for two or more departments |
| Peripheral Specialist | Designer of a high-tech component whose current interest is in further scientific research vice application of previously discovered technology |
| Pulse Taker | Certifying official for an industry responsible for assigning grades relating to |

managers are typically unwilling to offer access to stakeholders for a "science project." Second, even if this hurdle was overcome, stakeholders who participated would be eager to see the results. This could potentially put the program manager in the uncomfortable position of explaining to a senior company official (or military officer) why he or she was not found to be a legitimate and/or powerful stakeholder.

For the reasons stated above, the network map proposed for this framework is created in-house by program personnel familiar with the roles, responsibilities, concerns, and personality of each stakeholder. It may be beneficial (or even necessary) to involve both systems engineers and program management staff while building the network map as stakeholder management requires knowledge of both the project or program domain and the product domain [Sharon, de Weck, and Dori, 2011]. Once the appropriate team is assembled, the network map is derived from known lines of influence while using the five social network roles defined by Anklam as guidance [Anklam, 2005]. These roles are summarized in Table III and demonstrative examples are provided in Table IV.

When building the Stakeholder Network Map (as discussed in Sec. 6 below), understanding a stakeholder's role can guide the team's work by helping them anticipate a either a small or large number of influence lines stemming from a particular stakeholder to other stakeholders associated with the program. For example, a peripheral specialist would likely influence a small number of other stakeholders while a central connector would likely influence a large number.

## 5. PILOT STUDY OVERVIEW

In order to test the feasibility of the proposed framework, a pilot study was executed [Wood, Sarkani, and Mazzuchi, 2011]. The following subsections provide general information regarding this pilot study, significant results, and the lessons learned. Further details on the execution of the pilot study are provided in this paper's Appendix.

### 5.1. Program and Personnel Background

The program personnel that participated in the pilot study were involved in a DoD acquisition effort that anticipated spending more than $140 million (in US Fiscal Year 2000 constant dollars) in research, development, test, and evaluation. In DoD terms, this program was classified as Acquisition Category II [US Department of Defense, 2008]. The goal of the program was to field IT-based equipment that would support multiple branches of the armed services, incorporate stringent security policies, and operate at extremely high levels of availability. At the time of the pilot study, the first fielding of operational equipment was scheduled to occur after 7 years of further development and testing.

The personnel participating in the pilot study all served in systems engineering roles and had between 2 and 4 years of experience with this program. Their efforts closely align with domain B3 of the Friedman and Sage case study framework [Friedman and Sage, 2004]. In other words, they were involved in the system architecture and conceptual design, and their efforts fall under the responsibility of the government sponsor (*vice* the development contractor).

### 5.2. Pilot Study Results

Upon completion, the pilot study was considered a success. Although the daily time estimates were not precise, the overall effort required less than 6 h for the three program team members. The following paragraphs detail the pilot study results.

Initial efforts revealed 32 active stakeholders from a variety of communities. A matrix for each program phase (see Table I) was created that classified each stakeholder's concern in terms of power, legitimacy, and urgency (see Table II) relative to the information captured in each of the program's existing 15 architecture framework artifacts. Interestingly, the team observed that the quantity of stakeholders categorized as legitimate (per the definition of Mitchell, Agle, and Wood [1997]; see Table II) for the information captured in a particular view was usually between 1/2 and 2/3 of the total stakeholders active for that view.

Next, an additional matrix was created that summarized the time-phased evolution of each stakeholder's classification (using the definitions provided by Mitchell, Agle, and Wood [1997], see Table II) for each architecture framework artifact. In this specific case, the team observed at least one stakeholder category change through the phases for every architecture framework artifact except for two operational views. It was also noted that the category of urgency (per the definition of Mitchell, Agle, and Wood [1997]; see Table II) was decidedly missing from most stakeholder classifications (likely due to the fact that this team supported a multiyear acquisition effort with an initial fielding expected to occur several years in the future).

Network maps were created for each program phase (see Table I). As desired, the paths of stakeholder influence were clearly visible; however, the maps revealed additional information. Upon completion of these maps, the study team quickly realized that, for each phase, more than one network was in play. This revelation was similar to that discovered in other disciplines [Soh, Chua, and Singh, 2011]. It also became clear that certain stakeholders have a plethora of other stakeholders directly influencing them. The team recognized the obvious management nightmare this poses (due to stakeholder overload) and brainstormed ways to lessen this burden (such as having designated representatives for natural groupings).

While the social networking roles (see Table III) of some stakeholders were identified prior to creating the network maps, the maps revealed additional roles performed by particular stakeholders. The analysis found that central connectors and boundary spanners were the easiest to identify on the maps. It was also noted that all roles identified by Anklam were present in the program, but not every role was present in every phase of the program [Anklam, 2005]. Based on the resultant network map, the team observed one additional and very important item: A central connector had not been previously identified by the team as a major stakeholder (possessing two or more of the Mitchell, Agle, and Wood [1997] categories), thus exemplifying and clarifying the difference between perception and facts.

At the completion of the study, it was obvious to the participants that their relatively small time investment paid big dividends for the program team. The team now possesses a series of Stakeholder Crosswalks that allow them to identify which stakeholders are important for any particular decision at any time throughout the program's development. The team also has a map that identifies paths of influence for each particular stakeholder by graphically portraying which other stakeholders influence the target stakeholder. Further, the Stakeholder Network Map provides entry into a wide variety of Social Network Analysis tools and techniques.

The framework successfully mitigated the previously identified fears of performing stakeholder analysis [Bryson, 2003]. Specifically, the framework provided an easy to follow how-to guide; the time spent was minimal for the results; and, since the work was done in-house, the results can remain private. Finally, this effort did not require the use of specialized tools or software. All activities were successfully captured in the commonly available Microsoft Excel [Wood, Sarkani, and Mazzuchi, 2011].

### 5.3. Pilot Study Lessons Learned

The most important lesson learned is that the stakeholder system can be captured and characterized. When applied, the proposed framework provided an insight into the stakeholder system that previously had not been readily perceived. This pilot effort also provided insight into areas of the initial framework that could be improved.

One aspect of the Mitchell et al. classification that proved confusing for several members of the program team is that the value of the number associated with a stakeholder does not directly equate to the relative strength or importance of the stakeholder. Rather, these numbers are simply a convenient way to identify which characteristics a particular stakeholder possesses [Mitchell, Agle, and Wood, 1997]. An alternate, and perhaps clearer, method to accomplish the same task is to use letters that correspond to each of the three categories. In other words, use P for power, L for legitimacy, and U for

**Table V. Correlation of Mitchell, Agle, and Wood [1997] Numbers to Descriptive Acronyms**

| Characteristic(s) | Original Number | New Acronym |
|---|---|---|
| Power | 1 | P |
| Legitimacy | 2 | L |
| Urgency | 3 | U |
| Power, Legitimacy | 4 | PL |
| Power, Urgency | 5 | PU |
| Legitimacy, Urgency | 6 | LU |
| Power, Legitimacy, Urgency | 7 | PLU |
| None | 8 | N/A |

urgency (as defined in Mitchell et al.; see Table II), and combine them when multiple categories apply to a particular stakeholder. This new categorization identifies the stakeholder characteristics outright and eliminates the need for a legend to decode the categories. A mapping of original Mitchell et al. numbers to new acronyms is provided in Table V.

The pilot team also found an effective way to speed up the stakeholder classification by grouping the architecture framework artifacts and grouping the stakeholders on the matrices. Architecture framework artifacts were grouped by viewpoints (e.g., all Operational Views were listed followed by all System Views). Stakeholders were grouped by their Community of Interest (e.g., all acquisition stakeholders were listed followed by all evaluation stakeholders). The grouping made the effort very efficient and allowed liberal use of "copy and paste," since members of any particular Community of Interest generally had the same characteristics relative to a particular viewpoint. In fact, it took less than 1 h to complete 480 cells (15 architecture framework artifacts × 32 individual stakeholders).

Identifying a key concern for each stakeholder also proved helpful. At times the pilot team would stall or hesitate when classifying a particular stakeholder. This was often overcome by focusing on the key concern for that stakeholder. This focus helped the pilot team to dismiss the less important traits or concerns of that particular stakeholder.

The final lesson learned was that manually drawing out the stakeholder network within Excel was unexpectedly time-consuming and tedious. Following the pilot study, the authors

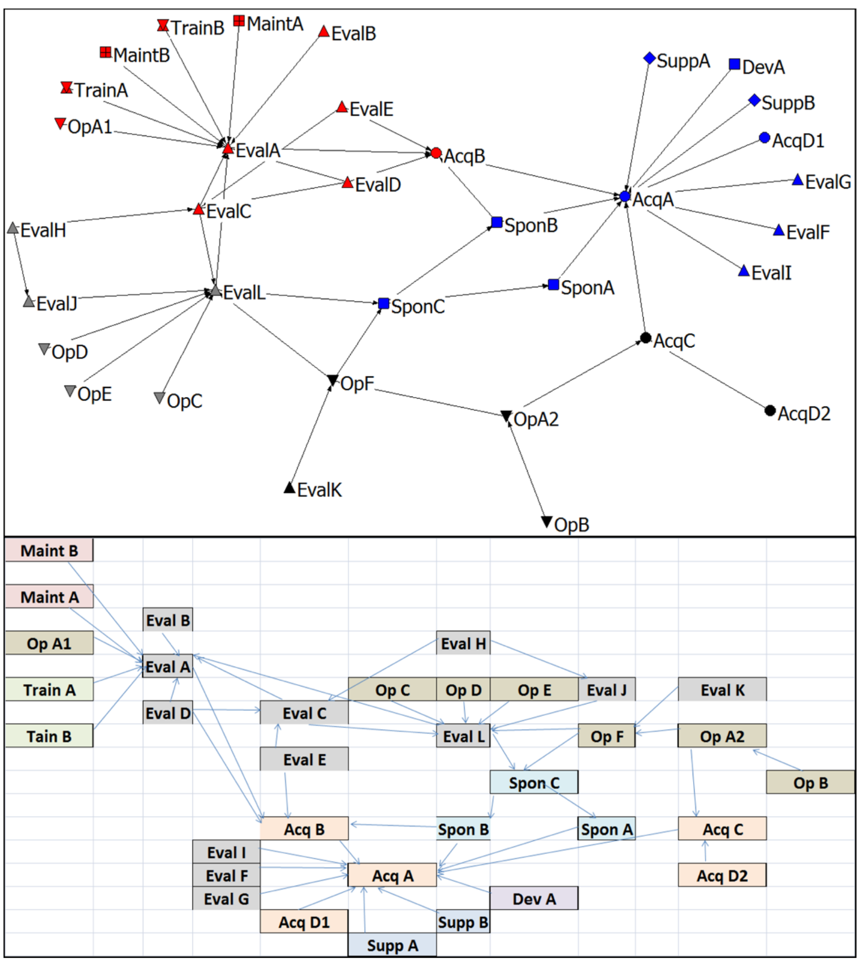


**Figure 3.** Comparison of study results in NetDraw and Excel. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

experimented with NetDraw social network analysis software. The use of NetDraw allowed for quicker organization and creation of the network map, allowed for easier visualization (see Fig. 3), and also allowed for more comprehensive analysis. In fact, NetDraw identified an additional subgroup that the pilot team had not discovered while working with the Excel map. Software of this type does not require the e-mail mining or surveys discussed above. It simply allowed the team to input their knowledge of stakeholder relationships and have the software transform that knowledge into a stakeholder network map. This software is free for use; however, depending on local IT rules, it may not be an option for some program offices. For example, utilizing NetDraw on a strictly controlled Navy-Marine Corps Intranet (NMCI) workstation is not immediately permissible. In situations where social network software is not permitted, the stakeholder network maps can still be hand-built within Microsoft Excel (as proven during the pilot study).

## 6. DETAILED FRAMEWORK FOR CAPTURING THE STAKEHOLDER SYSTEM

The authors propose the framework described below (which incorporates the lessons learned from the pilot study) as a means to realize the aforementioned Stakeholder Crosswalks and Stakeholder Network Maps. The framework is divided into five steps: Process Introduction & Stakeholder Identification, Stakeholder Classification, Time-Phasing and Analysis, Stakeholder Network Map Creation, and Social Role Analysis. The following subsections provide detailed information regarding the purpose of each framework step and the proposed method for executing that step. As stated previously, these tools are intended to assist an organization in performing stakeholder analysis and are also expected to be useful in support of tradeoff decisions that result from the organization's existing requirements analysis techniques.

### 6.1. Step 1: Process Introduction & Stakeholder Identification

Once a willing team of program subject matter experts is assembled, the facilitator should briefly describe the goals of this effort and the process being undertaken to accomplish those goals. The overall goal is to identify the primary areas of interest for each stakeholder and illustrate how each stakeholder interrelates with other program stakeholders over the program's lifecycle. This will be realized by building Stakeholder Crosswalks and Stakeholder Network Maps via the five proposed steps.

Next, the landmark definition of a stakeholder ("any group or individual who can affect or is affected by the achievement of the organization's objectives") should be provided [Freeman, 1984: 46]. The team members should then take a few moments to individually brainstorm potential stakeholders. Back in a group setting, the identified stakeholders should be listed across the first row in an Excel spreadsheet. Also, the team should confirm that, at a minimum, they have captured the users of the system, acquirers of the system, developers of the system, and maintainers of the system as recommended by ISO 42010/IEEE 1471 [ISO, 2007; IEEE, 2000].

The stakeholders should then be grouped within communities of interest such as those identified in the NATO Architecture Framework [NATO Consultation, Command and Control Board, 2007]. Some typical communities of interest include: Acquisition Management, Requirements Management, Operations, Sustainability, and Tool Vendor.

Next, each stakeholder's top one or two concerns should be captured. These concerns form an abstracted view that highlights the top goals each stakeholder hopes to achieve [Pohl, 2010]. This approach is consistent with IEEE 1471 as identified in Maier, Emery, and Hilliard [2004]. These concerns may be in the form of key drivers as defined by Muller [2004] and employed in FunKey architecting [Bonnema, 2010; Bonnema et al., 2010]; however, at a minimum the concerns identified should include: the mission of the system, the appropriateness of the system, the feasibility of constructing the systems, risks in development and operation, maintainability of the system, deployability of the system, and the evolvability of the system [ISO, 2007; IEEE, 2000].

The desired outcome of Step 1 is a list of potential stakeholders. Each stakeholder will be grouped by community of interest. Also, documented with each stakeholder will be that stakeholder's key driver(s). If the time and situation allow, the team should work with program stakeholders to validate the team's understanding of the stakeholder's role and concerns. An example extract of the resulting spreadsheet is provided in Figure 4.

### 6.2. Step 2: Stakeholder Classification

The second session should open with a brief recap of the efforts performed during the previous session. Next, the approach to stakeholder classification should be introduced. This approach, proposed by Mitchell et al., describes a stakeholder by his or her possession of power, legitimacy, and/or urgency [Mitchell, Agle, and Wood, 1997]. The definitions of those terms (as summarized in Table II) should be provided to help guide discussions. The spreadsheet from the previous session should be populated with a listing of existing architecture framework artifacts. For instance, the pilot study populated one row for each of the 15 DoDAF models contained in that program's Information Support Plan. If architecture products do not yet exist for the program, the performing team can use descriptions of products from their preferred architecture framework as a starting point. Focusing on one architecture framework artifact at time, the team should add a P, U, and/or L (representing power, urgency, legitimacy) for each stakeholder depending on how the team felt that stakeholder would deal with changes to the program as captured in that particular architecture framework artifact.

| COI | Evaluation | | |
|---|---|---|---|
| Stakeholder | Eval A | Eval B | Eval C |
| *Key Driver(s)* | *Mission* | *Feasibility* | *Compliance, Mission* |

**Figure 4.** Sample outcome for Step 1.

| COI | Acquisition Management | | |
|---|---|---|---|
| Stakeholder | Acq A | Acq B | Acq C |
| *Key Driver(s)* | *Cost, Schedule* | *Compliance with Standard Process* | *Application of Documented Best Practices* |
| | | | |
| AV-1 | PLU | L | P |
| AV-2 | PLU | L | P |
| | | | |
| OV-1 | PU | N/A | P |
| OV-2 | PU | N/A | P |
| OV-3 | PU | N/A | P |

**Figure 5.** Sample outcome for Step 2.

During this stage of the effort, only the current program phase (such as those defined by DoDI 5000.02 and summarized in Table I) should be considered [US Department of Defense, 2008].

The desired outcome for Step 2 is the first Stakeholder Crosswalk. This is a matrix that correlates each stakeholder's level of interest with the information captured in each architecture framework artifact as anticipated in the current program phase. As mentioned previously, grouping stakeholders by type and architecture framework artifact by viewpoint can make the effort very efficient. Figure 5 provides a truncated example outcome for a program employing DoDAF.

## 6.3. Step 3: Time-Phasing and Analysis

As before, this session should start out with a recap of the previous session. Next, a brief explanation of the program phases (such as those defined by DoDI 5000.02 [US Department of Defense, 2008] and summarized in Table I) should be provided. The spreadsheet built during the prior session should be replicated several more times in order to provide a basis for evaluating future phases of the program. (Note: This number will vary depending on the phase in which the program currently resides.) Finally, an additional tab can be created to automatically populate the stakeholder classification for each phase for each stakeholder for each architecture framework artifact. This will provide a means for viewing how each stakeholder's classification changes as the program progresses. Next, the team should consider how the program will evolve with each phase, and what areas will be more or less important to particular stakeholders. The team should document these changes in stakeholder classifications for each model in each phase.

The desired outcomes of Step 3 are Stakeholder Crosswalks for upcoming phases of the program and a time-phased rolled-up summary crosswalk that illustrates how each stakeholder's concerns (per the Mitchell, Agle, and Wood [1997] definition; see Table II) change over time (see Fig. 6 for an example using DoDAF [US Department of Defense, 2009a, 2009b] and the program phases defined in DoDI 5000.02 [US Department of Defense, 2008]). Note: Even with narrowing the focus to only the differences per phase (vice re-creating the entire spreadsheet for each phase), this step is time-intensive.

| COI | Operations | | |
|---|---|---|---|
| Stakeholder | Op A | Op B | Op C |
| *Key Driver(s)* | *Mission, Promotion* | *Profit, Reputation* | *Mission* |
| | | | |
| SV-4a | | | |
| TD Phase | N/A | N/A | P |
| EMD Phase | N/A | N/A | P |
| P&D Phase | L | L | PL |
| O&S Phase | L | L | PL |

**Figure 6.** Sample outcome for Step 3.

## 6.4. Step 4: Stakeholder Network Map Creation

After discussing the efforts from the previous session, the team should be introduced to basic social network analysis techniques. A good reference is the article titled "The People Who Make Organizations Go—or Stop," which contains social network role definitions accompanied with example graphics [Cross and Prusak, 2002]. Next, the team should embark on building a Stakeholder Network Map for each phase of the program starting with the current phase. Two approaches for building the map are provided below.

If IT-constrained, the team can build the network map using spreadsheet software such as Microsoft Excel. Using a cell for each stakeholder, the team can populate a blank spreadsheet. Starting with themselves and working out, the team can use arrows to indicate primary lines of influence. In other words, starting with "Stakeholder A," identify whom that stakeholder listens to or is strongly influenced by (for example, Stakeholders B and C). Then lines should be drawn to reflect those influences. Next, move to Stakeholder B and repeat the process. Continue these iterations until the primary influencers of each stakeholder have been identified and mapped. Note: As experienced in the pilot study, the lines of influence may change as the program progresses; therefore, separate network diagrams should be drawn for the subsequent program phases.

If the team's IT environment allows, social network analysis software such as the free version of NetDraw can be utilized to automatically create the Stakeholder Network Maps. If NetDraw is chosen, the authors recommend inputting the data via the Nodelist DL format. To accomplish this, the team should work their way through the list of stakeholders one at a time. For each stakeholder, the team identifies the primary influencer(s) and documents them in a text file as described in *A Brief Guide to Using NetDraw* [Borgatti, 2002]. Once complete, this text file is imported into the software, and the network map is automatically created. The desired outcome of Step 4 is a set of Stakeholder Network Maps (one for each phase of the program). Figure 7 provides an example outcome using NetDraw.

## 6.5. Step 5: Social Role Analysis

After recapping the events of the previous session and viewing the network maps, the team should work on identifying any subgroups within each network map. As experienced during the pilot study and other research, multiple subgroups are likely to exist within each phase in the program [Wood,

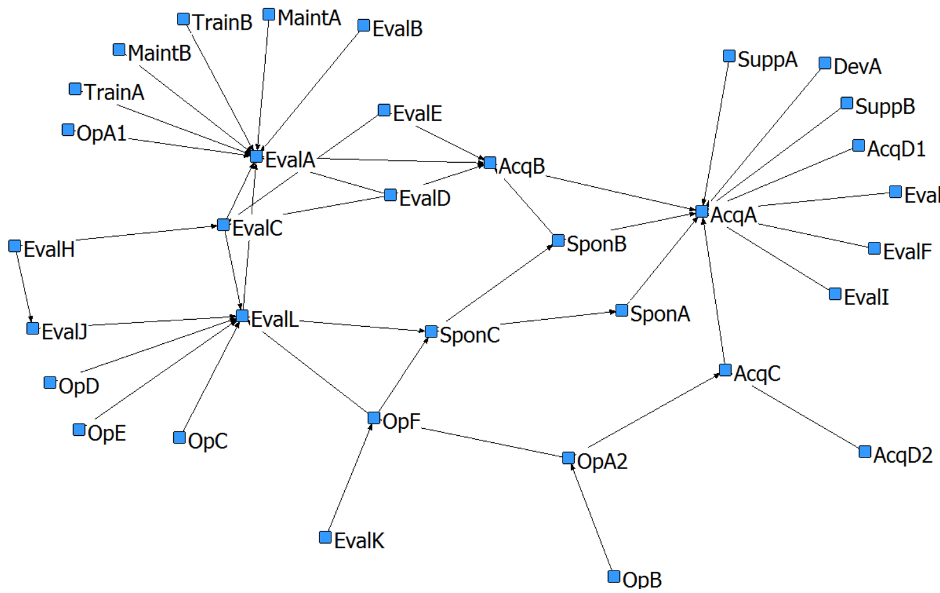


**Figure 7.** Sample outcome of Step 4. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

Sarkani, and Mazzuchi, 2011; Soh, Chua, and Singh, 2011]. If spreadsheet software was utilized in Step 4, then the team can work to manually identify subgroups (characterized by clusters). If social network analysis software was utilized, the software's inherent analysis capabilities can be leveraged to identify subgroups (see Fig. 8). These subgroups should then be named by the team to facilitate future references.

Next, the team should examine social network roles. Taking one network map at a time, the team should identify key social network roles that various stakeholders perform. The pilot study team found the definitions provided by Anklam [2005] particularly useful (see Table III). The study team was able to find each of the five roles identified by Anklam in their Stakeholder Network Maps (although not all five roles were present in each phase). Finally, the description of each stakeholder should be augmented with his or her subgroup memberships (by program phase) along with any social network roles the stakeholder fulfilled.

The outcome of Step 5 is the identification of stakeholder subgroups and documentation of stakeholder memberships and social network roles.

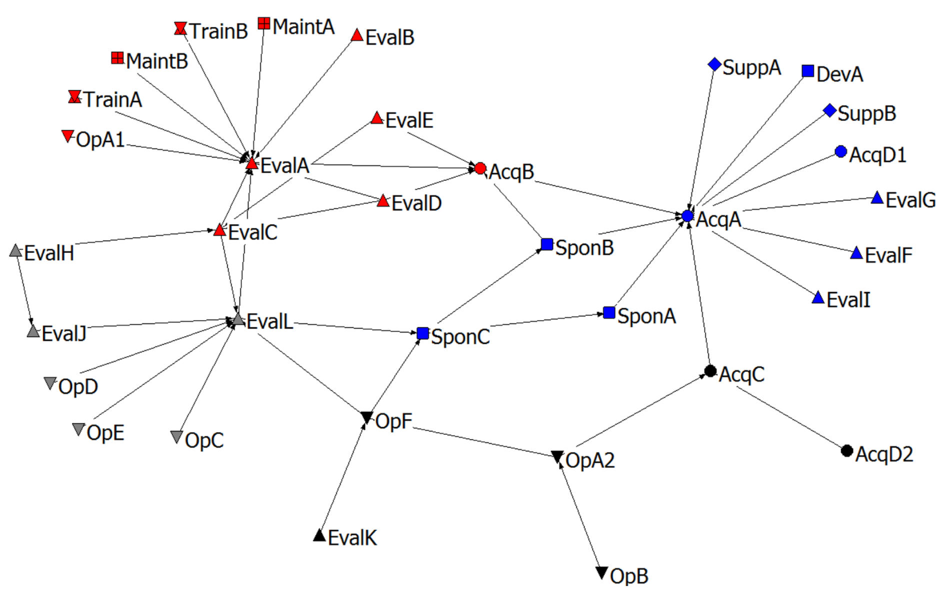


**Figure 8.** Sample outcome of Step 5 using NetDraw (different colors denote different subgroups). [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

### 6.6. Completed Framework

At the end of Step 5, the team now has a completed set of Stakeholder Crosswalks and Stakeholder Network Maps that capture the "socio" side of the enterprise's complex sociotechnical system [Giachetti, 2010]. These products, which detail stakeholder interrelations throughout the system development lifecycle, can be used for future tradeoff decisions (examine the row that corresponds to the particular architecture framework artifact that best describes the item being evaluated and determine which stakeholders are most affected). The products can also be used to build winning coalitions for volatile topics (identify the key stakeholder opposing the idea, view his or her location on the Stakeholder Network Map, and strategize a plan to systematically address other stakeholders that influence the target stakeholder). Additionally, with the possession of a Stakeholder Network Map, the program team can now apply a variety of Social Network Analysis tools and techniques documented in the rich literature of Social Network Analysis including several references identified in this paper [Anklam, 2005; Cross and Prusak, 2002; Ehrlich, Yin, and Griffiths-Fisher, 2007; Liebowitz, 2005; Prell, Hubacek, and Reed, 2009; Scott and Carrington, 2011].

As the program progresses, the stakeholder landscape will likely change. New stakeholders may emerge, while others may disappear. New personalities may exhibit more or less power and urgency than their predecessors. Even if the people remain the same, the politics, budgets, and technologies will likely change in ways that affect the program's stakeholders and create new key drivers [Piaszczyk, 2011]. For these reasons, the Stakeholder Crosswalks and Stakeholder Network Maps developed through the use of this framework should be reevaluated and updated on a recurring basis. This reevaluation can be annually or, at a minimum, in conjunction with each major program milestone (such as those defined within DoDI 5000.02 [US Department of Defense, 2008]).

### 6.7. Framework Weakness

During the execution of the pilot study, only one weakness was identified that could not be addressed by modifying the framework itself. This weakness is that the framework assumes the program team possesses an initial understanding of the stakeholder roles and personalities associated with their program. This may not be the case if this is a brand new program or if the engineer is new to the program.

While this weakness cannot be mitigated by modifying the framework, there are still means to mitigate the weakness. For example, if the framework is being applied to a brand new program, engineers from similar programs can be queried for their knowledge of potential stakeholder roles and personalities. If this framework is being executed by an engineer new to the program, he or she can seek assistance from more experienced members of the program team who have personally witnessed stakeholders in action. Furthermore, if this framework is adopted by an organization, the results of each instance can be added to a repository. This ever-growing and refining repository of stakeholder traits can be used as a starting point for new programs desiring to employ this framework.

In addition to the steps above, a collection of heuristics could prove to be an important mitigation. Heuristics could be collected that focus on identifying stakeholders, determining a stakeholder's key driver(s), correlating stakeholders to specific social network roles, and identifying patterns of influence. These heuristics could build upon those provided by ISO/IEEE, Keeney, Rechtin, and Maier and Rechtin, using the heuristics guidelines set forth in Chapter 2 of *The Art of Systems Architecting* [ISO, 2007; IEEE, 2000; Keeney, 1992; Rechtin, 1991; Maier and Rechtin, 2002].

## 7. FICTICIOUS APPLICATION

The following fictitious scenario is intended to provide an example usage of the architectural products created via the application of the framework documented in this paper. Inspired by the use case provided by Hari, Kasser, and Weiss [2007], the product being designed in the simplistic example below is a new flashlight intended for security guards.

### 7.1. Problem Identification

During requirements analysis, a program team determines that providing a means to momentarily illuminate the bulb in the new flashlight impairs the design team's ability to reduce the new flashlight's weight and the ability to reduce the effort required to engage the constant illumination switch. The team also realizes that the requirement in question is of lower priority than the two requirements with which it conflicts. The requirement for the momentary illumination feature was levied by the Operations Community of Interest and is best depicted in the program's SV-5 diagrams, which depict the relationship between operational activities and the system functions required to support desired features.

### 7.2. Using the Stakeholder Crosswalk

The team references their Stakeholder Crosswalk and observes that there are two legitimate stakeholders (per the Mitchell, Agle, and Wood [1997] definition, see Table II) with interest in this item. These two stakeholders oversee the operational community. During this example, these stakeholders will be referred to as L1 and L2. The team also recognizes there is an additional stakeholder (a former operator, now engineer) who wields power (per the Mitchell et al. definition; see Table II) among other stakeholders with regard to operational issues. This stakeholder will be referred to as P1. Then, the team looks at their time-phased roll-up summary Stakeholder Crosswalk and identifies a stakeholder that is expected to emerge in a future phase of the program. This stakeholder is a member of the testing community, who is rated as both powerful and legitimate (per the Mitchell et al. definition; see Table II) in the Production and Deployment Phase (see Table I). This stakeholder will be referred to as PL1.

Informal phone calls are made to L1, L2, and P1 to describe the situation and proposed solution. L1 and P1 understand the need to achieve the higher priority requirements and express hesitant support for eliminating the momentarily illumination requirement. L2, however, does not support this recommendation.

### 7.3. Using the Stakeholder Network Map

Using the Stakeholder Network Map, the team sees that L2 is heavily influenced by the senior user of the legacy flashlight that is due to be replaced by the new design. Viewed individually, this stakeholder does not possess power, legitimacy, or urgency (per the Mitchell, Agle, and Wood [1997] definition; see Table II); however, the program team sees that this stakeholder's relationship with L2 makes him powerful in this scenario. During this example, the new stakeholder will be referred to NA1.

The team makes a call to NA1 to explain the situation and proposed elimination of the momentarily illumination requirement. NA1 agrees with the proposed approach, noting that the current crew of security guards does not use the momentary illumination button found on the legacy flashlight. The senior guard explains that the requirement is a holdover from a time when the security guards used flashing light signals to communicate at night. Now, the security guards utilize two-way radios that were fielded after the original flashlights were put into service.

Relatively confident the requirement can be overturned, the program team hosts a formal requirements review with L1, L2, P1, PL1, and NA1. The team presents their case on how the momentary illumination feature would hamper design team's ability to reduce the new flashlight's weight and the ability to reduce the effort required to engage the constant illumination switch. Next, the team asks NA1 how often the momentary illumination feature is used during typical operations. NA1 provides the meeting attendees with the same answer that was previously provided to the program team (i.e., it is no longer used to communicate now that radios have been provided).

The program team initiates a poll, and requests each member provide either concurrence with eliminating the momentary illumination requirement or nonconcurrence. The team first asks NA1 who promptly concurs with eliminating the requirement. Next, they ask P1 who also concurs. Now, the team asks L1 to concur or non-concur. L1 concurs. After a deep breath, the program team requests L2 provide concurrence or non-concurrence. L2 also concurs. Finally, the team asks PL1 for concurrence or nonconcurrence. PL1 concurs. Following the meeting, the program team drafts meeting minutes and updates the requirements documentation to reflect the agreed upon changes.

### 7.4. Example Benefits to the Program

During the fictitious example provided above, the program team experienced a variety of success that can be attributed to their use of Stakeholder Crosswalks and Stakeholder Network Map. These benefits are summarized in Table VI below.

**Table VI. Example Benefits**

| Benefit | Discussion |
|---|---|
| Right-Sized Stakeholder Involvement | Only 5 out of 15 program stakeholders were involved in the decision making process. |
| Effective Use of Resources | The team was able to quickly identify a path to convince an opposing stakeholder of the benefit of the proposed approach.<br>The team was able to identify the benefit of involving a system tester at the requirements meeting and potentially eliminated contention during future test events. |
| Stakeholder Commitment | All stakeholders that would be affected or who could affect the product with regard to the requirement in question jointly decided upon the change in requirements early in the design phase. |

## 8. FUTURE WORK

While the pilot study successfully showed that stakeholder interrelations can be captured without expensive tools and with relatively little time investment, future work should explore the employment of the Stakeholder Crosswalk and Stakeholder Network Map [Wood, Sarkani, and Mazzuchi, 2011]. These studies could examine the effectiveness of the tools during the execution of tradeoff decisions or in coalition building.

Other studies could be performed that explore variations of the Stakeholder Crosswalk and Stakeholder Network Map such as applying different stakeholder and/or social network approaches. Studies could also be performed that merge this framework with other development approaches such as the Incremental Commitment Model which holds stakeholder satisficing as a key principle for program success [Boehm and Lane, 2008].

## 9. SUMMARY

Managing stakeholder relations and interrelations is critical to program success. If these efforts are ignored, program sponsors will needlessly waste funds on ineffective solutions and rework—a path that is unacceptable, especially in fiscally constrained environments such as those currently faced by many organizations. This paper described how popular architecture frameworks successfully capture the views of program stakeholders but fail to capture the interrelations of these stakeholders [a system with $n*(n-1)/2$ interfaces]. Stakeholder Crosswalks and Stakeholder Network Maps were introduced as tools that can accurately capture and characterize this stakeholder system. A repeatable framework was offered as a means to reliably build these products. The framework and resulting products provide a unique insertion of Social Network Analysis into Architecture Framework and fulfill an original intent of Architecture Framework by capturing the *entire* sociotechnical system. Through the application of these architectural products, the authors anticipate systems engineers will be able to field systems more efficiently and field them with the assurance of lasting stakeholder commitment.

## APPENDIX: PILOT STUDY EXECUTION

This appendix details the execution of the pilot study performed in order to test the feasibility of creating Stakeholder Crosswalks and Stakeholder Network Maps [Wood, Sarkani, and Mazzuchi, 2011]. This section was separated from the main paper in order to reduce confusion with regard to the framework steps. The steps performed during the pilot study are similar to those proposed in the framework described above but do not contain the refinements that were subsequently incorporated based upon the lessons learned while performing the pilot study.

### A.1. Background Information

After a briefing describing the impact of stakeholders, a discussion of the literature review undertaken, and an introduction to the proposed framework; a program from the US Navy's Space and Naval Warfare Systems Center volunteered three members to execute the pilot study.

The personnel participating in the pilot study all served in systems engineering roles and had between two and four years of experience with this program. Their efforts closely align with domain B3 of the Friedman and Sage case study framework [Friedman and Sage, 2004]. In other words, they were involved in the system architecture and conceptual design, and their efforts fall under the responsibility of the government sponsor (vice the development contractor).

The program personnel that participated in the pilot study were involved in a DoD acquisition effort that anticipated spending more than $140 million (in US Fiscal Year 2000 constant dollars) in research, development, test, and evaluation. In DoD terms, this program was classified as Acquisition Category II [US Department of Defense, 2008]. The goal of the program was to field IT-based equipment that would support multiple branches of the armed services, incorporate stringent security policies, and operate at extremely high levels of availability. At the time of the pilot study, the first fielding of operational equipment was scheduled to occur after seven years of further development and testing.

The proposed effort consisted of five steps and was anticipated to take a total of 5 h spread over 5 days. The five steps and initial time estimates are: (1) Stakeholder Identification (45 min), (2) Stakeholder Classification (1.5 h), (3) Time-Phasing and Analysis (30 min), (4) Stakeholder Network Sketch (1.5 h), and (5) Social Role Analysis (45 min).

### A.2. Step 1: Stakeholder Identification

The goal of Step 1 was to create a list of potential stakeholders. Since this was the first step in the process, approximately 10 min were dedicated to introducing the background, motivation, and theory behind the framework as well as describing the framework itself. Next, the landmark definition of a stakeholder ("any group or individual who can affect or is affected by the achievement of the organization's objectives") as well as general stakeholder groupings (e.g., acquirers, sponsors, evaluators, etc.) were provided [Freeman, 1984]. At this point, team members took approximately 5 min to individually brainstorm. Back in a group setting, stakeholder organizations were listed across the first row in an Excel spreadsheet. The organizations were then grouped by type with each stakeholder's top one or two concerns also being captured. In all, 31 stakeholders were identified and captured in Excel. Including time spent on the introductory material, the first session lasted approximately 1 h.

### A.3. Step 2: Stakeholder Classification

At the beginning of the second session, a brief recap of the previous session was presented. At this time, one team member introduced an additional stakeholder that was added to the spreadsheet. Next, a common approach to stakeholder classification was introduced [Prell, Hubacek, and Reed, 2009]. This approach, captured by Mitchell, Agle, and Wood [1997], describes a stakeholder by his/her possession of power, legitimacy, and/or urgency. The Mitchell et al. definitions of those terms were also provided to help guide discussions. The spreadsheet from the previous session was augmented with a listing of existing DoDAF products. Three rows were dedicated to each of the 15 models created in support of the program's Information Support Plan; these rows represented power, legitimacy, and urgency. The team focused on the current phase of the program and answered yes or no to the three categories for each stakeholder, depending on how the team felt that stakeholder would deal with changes to the program as captured in each particular DoDAF model.

The team saw merit in focusing on the category questions vice numbers. Doing so appeared to keep the results from influencing decisions (the numerical categorization as proposed by Mitchell, Agle, and Wood [1997] was accomplished in a separate spreadsheet utilizing formulas in Excel). The listing of primary concerns was often referenced when determining which categories were in play for a particular stakeholder. The grouping of stakeholder (by type) and DoDAF models (by viewpoint) made the effort very efficient. In fact, it took less than 1 h to complete 480 cells (15 models × 32 stakeholders).

### A.4. Step 3: Time-Phasing and Analysis

As before, this session started out with a recap of the previous session. Next, a brief discussion was provided on the program phases as defined in DoDI 5000.02. Those phases are: Materiel Solution Analysis, Technology Development, Engineering and Manufacturing Development, Production and Deployment, and Operations and Support [US Department of Defense, 2008]. The spreadsheet built during the prior session was then replicated three more times in order to provide a basis for evaluating future phases. (Note: Only a total of four phases were captured, since the program was already in the Technology Development Phase.) Finally, an additional tab was created that automatically populated the stakeholder classification for each phase for each stakeholder for each Do-

DAF model. This allowed for viewing how each stakeholder's classification changed as the program progressed.

While the team's focus was narrowed to just the differences per phase (vice recreating the entire spreadsheet for each phase), the effort took closer to 1.25 h. Although time intensive, the team found merit in evaluating the time-phased roll-up summary. As observed in the previous session, stakeholder groups tended to have very similar scores for each DoDAF viewpoint. It was also noted that there was at least one stakeholder category change through the phases for every model except for the OV-1 and OV-4. The Production and Deployment Phase and the Operation and Sustainment Phase were tied with the highest number of active stakeholders (28 for each). The DoDAF model with the most interest was the SV-5a. The quantity of stakeholders categorized as legitimate was usually between 1/2 and 2/3 of the active stakeholders. It was also noted that the category of urgency was decidedly missing from most stakeholder classifications.

## A.5. Step 4: Stakeholder Network Sketch

After discussing the previous session's efforts, the team was introduced to typical social network analysis approaches and the deficiencies of those approaches for this effort. Software that relies on e-mail usage works great in a corporation but is unable to traverse the multiple DoD and contractor networks in play. Interviewing stakeholders may work for some fields, but it presents two major problems in the DoD. First, program managers are typically unwilling to offer access to stakeholders for a "science project." Second, even if this hurdle was overcome, stakeholders who participated would be eager to see the results. This could potentially put the program manager in the uncomfortable position of explaining to a senior officer why that officer is in fact not a legitimate and/or powerful stakeholder.

The team was then introduced to the following social network roles: Central Connector, Broker, Boundary Spanner, Peripheral Specialist, and Pulsetaker. These terms were defined using the verbiage provided by Anklam [2005] and augmented with pictures provided by Cross and Prusak [2002]. Using a blank tab in Excel, the team plotted stakeholders and interconnected them with arrows. These arrows indicated primary lines of influence. As before, the effort started with the current phase of the program since that is the phase with which the team was most familiar. It was then determined that separate network diagrams should be drawn for the subsequent phases, as the lines of influence were anticipated to change.

In all, this effort took close to 1.5 h. The large workspace in Excel proved very useful; however, different software could create more visually pleasing displays. Two things became apparent with the diagrams. First, for each phase, more than one network is in play. This revelation was similar to that discovered by Soh, Chua, and Singh [2011]. Second, it became clear that certain stakeholders have a plethora of other stakeholders directly influencing them. The team recognized the management nightmare this poses (due to stakeholder overload) and brainstormed ways to lessen this burden (such as having designated representatives for natural groupings).

## A.6. Step 5: Social Role Analysis

After recapping the events of the previous session and viewing the network maps, the team returned to the definitions provided by Anklam [2005]. Then, evaluating one phase at a time, the team dissected the network maps. First, the networks in play were identified on the map by their groupings around central connectors. These networks were then named for ease of future reference. Taking one network at a time, the team identified other roles that various stakeholders performed. Finally, the description of each stakeholder was augmented with their network memberships (by program phase) along with any roles they fulfilled.

The analysis found that central connectors and boundary spanners were the easiest to identify. It was also noted that all roles identified by Anklam were present in the program; however, not every role was present in every phase of the program [Anklam, 2005]. Paths of stakeholder influence became clearly visible on the diagram. One additional, and important, item arose: One central connector was not previously identified by the team as a major stakeholder (possessing two or more of the Mitchell et al. categories), thus exemplifying and clarifying the difference between perception and facts [Mitchell, Agle, and Wood, 1997].

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